Deltares

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Date	Our reference	Number of pages
14 April 2026	11209639-018-GEO-0004	1 of 4

Subject
Review: Navigational Risk Options – Terneuzen

Dear Mr ,

Deltares was asked to review the Document *Navigational Risk Options – Terneuzen* prepared by Amentum (Document no: 5060PR0007/FR-001, Revision: 01, 25 November 2025). It concerns an assessment of navigational risks to assist the Ministry of Economic Affairs (EZK) with ongoing technical evaluations for various sites to support the nuclear power program in the Netherlands.

The present memo provides a review of the above mentioned document. The present scope of work is limited to reflecting on the provided document from a nautical perspective; no additional simulations and/or calculations have been made. The interpretation of Cooling Water Modelling (Chapter 6) for the proposed alternatives has not been reviewed as part of the present scope, as it is not related to navigational aspects.

1 General observations

It is advised to consider the following observations:

- As acknowledged in the provided document, the chosen intake and outfall locations are near a major, international shipping route in a highly complex area, with many bends, tidal range, and non-uniform bathymetry. The Westen Scheldt is the main navigation channel to and from Antwerp and other ports and is used by the largest (tide bound) vessels in the world. Any changes that may negatively affect maneuverability in that area, are expected to receive resistance from captains, pilots and port authorities.
- The document presents several options for intake and outfall locations near a main navigation route. General information is provided on the main dimensions of the structures, but no information is given on the (changes in) flow fields produced by these intake and outfall stations. Sailing ships are sensitive to sudden changes in flow velocities, and especially cross-flows may affect their course and required path width. To make an

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assessment of the navigational impact of the presence of the intake and outfall heads, resulting flow fields should be evaluated for all considered options. In the evaluation of the flow fields, the effects of stratification should be sufficiently represented, as, due to temperature differences, highest flow velocities are expected to occur near the water surface, right where the ships are sailing. In Deltares (2025) (ref [2] in the document under review) discharges of 119.5 – 205 m^3/s are considered, and typical outfall head dimensions of 24 m x 8 m are mentioned by Amentum. This combination would result in minimum outflow velocities of 0.6 m/s - 1.1 m/s, although local flow velocities are likely to be higher. This is the same order of magnitude as the tidal flow velocities in that area, and hence significant enough to be considered carefully.

It is advised to consider the following evaluation steps when assessing navigation risks:

- Evaluation of flow fields – based on guidelines/expert judgement
  To compare the different intake/outfall location options, a first, order-of-magnitude comparison can be made by evaluating flow fields without performing dedicated maneuvering simulations. As a first step, available flow field computations can be reviewed to assess magnitudes of (cross-) flow velocities and flow gradients. If it is concluded that changes in flow velocities are small enough to be uninfluential, e.g. due to the relatively large distance of the head locations to the main and secondary navigation channels, this effect may be neglected in subsequent evaluation phases. Otherwise, it is advised to perform maneuvering simulation in a subsequent study phase.

- Perform fast-time maneuvering simulations
  A fast-time simulation model (e.g. SHIPMA or alike) can be used to quantify the effects of in/outflow currents on maneuvering behavior of the vessels in the navigation channel and anchorage area. Different layout options can be compared in a systematic way using such a fast-time simulation model.

- Verification through real-time maneuvering simulations
  If the effects on the flow patterns turn out to be crucial and an important design aspect, feasibility of maneuvers can be verified using detailed real-time simulations. (Preferably performed only in later design stages, due to the detailed input information required)

• Considering the assessment of collision risks, not only the impact of a collision on the structures need to be addressed (as now briefly mentioned in document under review), but also the impact of the collision on a vessel. The intake and outfall heads are large and hard structures, protruding above the seabed. In the main channel, vessel pass with drafts that are large enough to possibly hit these structures. In case of an engine and/or rudder failure, allision with these hard structure may result in structural damages to the vessels that are much more severe than when running aground on a gentle sloped bed of soft(er) soil. The increased impact of these collisions (on vessels and heads) should properly addressed in a nautical risk study, e.g. using a risk model like SAMSON (SAMSON | MARIN) or similar.

2 Detailed comments

P.6, Section 1.2: *"that the report is based on is based on"* – Word is missing

P.10, Section 4.2 Outfall heads: *"The Outfall Heads are not required to be LVSE as there is no danger of fish entrapment. They may be a diffuser type or a directed flow type, according to the requirements of the MPMZ"* - Outflow velocities may be of importance to influence on ship maneuvering. So from navigational perspective requirements for low outflow velocities may exist.

P.11: Section 5.1 Sub-Option A - Edge of Channel:
The intake heads of option 1A are located in the fairway (class VIb) providing access to the Braakmanhaven and the port of Breskens, see Figure 2.1 below (Source: https://vaarweginformatie.nl/). The impact on these navigation routes and accessibility to the port basins should be considered in the evaluation of different layout alternatives.

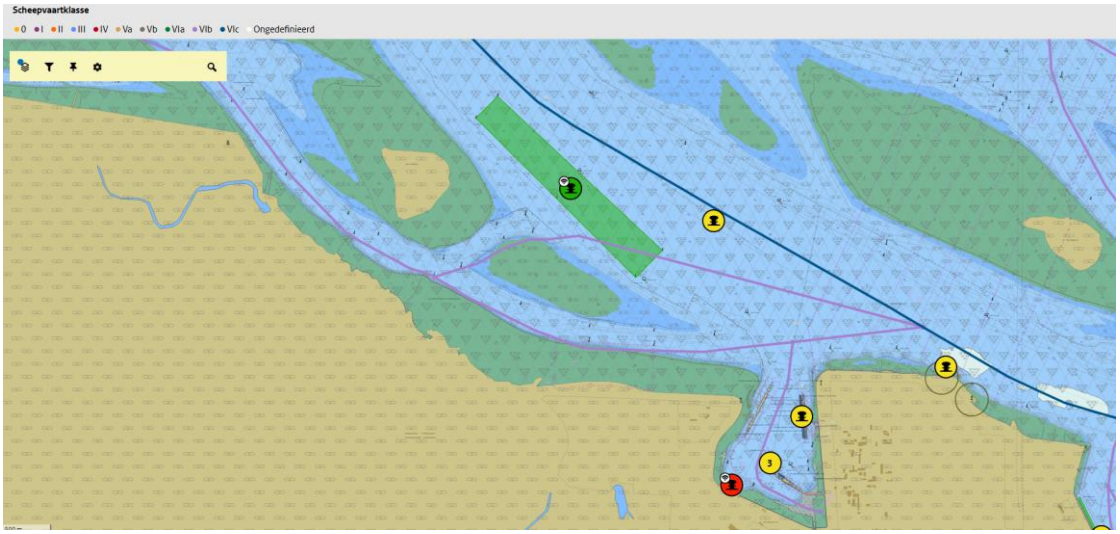

Figure 2.1 Sailing routes in the study area (: https://vaarweginformatie.nl/).

P12: *"1. The Heads are out of the navigation channel, therefore the possibility of impact from a ship in transit is low.*": The probability is low but not negligible and should be quantified using a risk assessment model. As the consequences (to ship and infrastructure) can be large, its contribution to the total risk should be evaluated and considered in the comparison of design alternatives.

P12: "*3. The Heads are close to the anchoring zone, therefore the possibility of an anchor dragging onto the Heads should be evaluated.*": Next to this, also the effects of the outflow currents on the moored vessels in the anchorage area should be assessed. Due to its proximity it is likely that it will be unsafe for mooring and/or sailing in (parts of) the present anchorage area.

P13, Section 5.2.1 Intake Heads: "*Intake Heads are in the inshore channel and at LAT are 13+m depth. This channel is understood to be used primarily by smaller lower draft vessels and therefore this would not be classed as an obstruction.*" They may not form a geometrical obstruction for the lower draft vessels, but its effect on local flow patterns will most likely have aneffect on maneuverability of the sailing vessels.

P13, Section 5.2.2 Outfall Heads: *"1. The Outfall Heads are out of the main channel, therefore the possibility of impact from a ship in transit is low."* See comment above (P. 12).

P13: Section 5.2.2 Outfall Heads: "*3. The Heads are close to the anchoring zone, therefore the possibility of an anchor dragging onto the Heads should be evaluated."*: See comment above (P. 12)

P13, Section 5.3 Sub-Option C – Intake in Main Channel: "*This option seeks to find the deepest water in the main channel and therefore to achieve the most clearance over the Heads for ships. In this manner the Heads are not a navigational hazard for the majority of vessels.* " The depth above the heads is reported to be 11.9 m – 13.3 m with respect to LAT. With a maximum draft of 16 m in the Western Scheldt, having such an obstruction that close to the edge of the navigation channel poses a threat to the largest vessels. Collisions of such large vessels (with lengths up to 400 m and a beams around 60 m), will have large consequences and risks should therefore not be ignored.

P17, Chapter 7. Conclusions: *"Preliminary Navigational Risk Assessment should be carried out by a marine expert with knowledge of the locality.*"
Fully agree. As input for such an assessment detailed flow fields should be provided for the different options under consideration.